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PROGRAM OF THE

RENO, NEVADA, MEETING

IN AFFILIATION WITH

PACIFIC DIVISION, A.A.A.S.

JUNE 23, 1927

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AMERICAN PHYSICAL SOCIETY

RENO, NEVADA, MEETING, JUNE 23, 1927.

The 146th regular meeting of the American Physical Society will be held at the University of Nevada, Reno, Nevada, on Thursday, June 23, in affiliation with the Pacific Division of the American Association for the Advancement of Science. The morning session will be held at 10:00 o'clock in Room 205, Mackay School of Mines. The afternoon session will be a joint one with the Astronomical Society of the Pacific, held at a time and place to be announced at the morning session.

Other meetings for the current season are as follows:

147. November 25–26, 1927. Chicago.

148. December 27–30, 1927. Nashville, Tenn. Annual meeting.

D. L. WEBSTER,

Local Secretary for the Pacific Coast.

PROGRAM

Thursday, June 23, at 10 o'clock

Room 205, Mackay School of Mines

1. A translucent black "board." W. WENIGER AND H. R. VINYARD, Oregon Agricultural College.—The solution of a difficult problem in blackboard illumination was obtained by abandoning the usual opaque board and substituting therefore a ground glass surface uniformly illuminated from the rear. With the customary room illumination, part daylight and part electric, everything on this "black board" was visible from all parts of the room, even from points making an angle of only 10° with the plane of the writing surface. Incidental advantages gained are: ease of erasure; ability to use the surface as a translucent screen for projecting lantern slides with the possibility of adding chalk lines to projected diagrams; ability to intersperse chalk talks with lantern slides without changing the general room illumination.

2. Remarkable electrical conditions accompanying west Texas sand storms. E. F. GEORGE, W. M. YOUNG AND HARRY HILL, Texas Technological College.—During West Texas sand storms the atmosphere is in a very unusual electrical condition. Severe shocks are sometimes received from radio antennas, fence wires and automobiles. Automobile ignition systems refuse to function in very severe storms. A radio antenna composed of stranded wire 0.19 cm in diameter and 33.75 meters long stretched at an elevation of 72.7 feet in an east and west direction between towers 282 feet apart, formed the basis of preliminary measurements. Prevailing storms are from the west. Potentials of over 40,000 volts, as measured by spark gap between spherical electrodes, have been obtained. Direct currents as high as 1.2×10^{-4} amperes have been measured. This corresponds to an atmospheric current density of 1.88×10^{-7} amperes per square centimeter, provided voltage and current are unaffected by friction of sand against wire. This value of atmospheric current density is about 10^8 times as great as that given in Humphrey's "*Physics of the Air*." Further measurements will be made with vertical wire to test the effect of direction and velocity of wind and quantity of sand carried.

3. Gas ion mobilities in $C_2H_2-H_2$ mixtures. L. B. LOEB AND L. DU SAULT, University of California at Berkeley.—The effect of NH_3, which forms an NH_4^+ ion in solution, in markedly raising the mobility of positive ions in H_2 gas, and the fact that C_2H_2 forms complex metal ions in solution which, according to Erikson, give mobilities of positive and negative ions that are almost equal, led the writers to study ion mobilities in $C_2H_2-H_2$ mixtures. The values found for mobilities in pure C_2H_2 which have not been carefully determined before were 0.708 cm/sec per volt/cm for the positive and 0.769 cm/sec per volt/cm for the negative ions on the generally accepted standard of 1.8 cm/sec per volt/cm for negative ions in air. On the new Absolute Standard of Loeb and Tyndall and Grindley, in which the negative ion in air has the mobility of 2.15 cm/sec per volt/cm, these values are 0.846 cm/sec per volt/cm for the positive ion and 0.906 cm/sec per volt/cm for the negative ion. It was found that the mobility of the negative ion was higher than that of the positive, because of the fact that the negative ion, even at atmospheric pressure, spends part of its career as a free electron. The mobilities in $C_2H_2-H_2$ mixtures could be computed within the limits of error from the theoretical equation, thus indicating the absence of any marked clustering on either ion and that the phenomenon occuring in NH_3-H_2 mixtures does not occur in $C_2H_2-H_2$ mixtures. These results indicate that positive and negative ions in C_2H_2 have the same mobility and that no specific clustering occurs. They thus explain observations of Erikson which appeared to introduce serious difficulties in Erikson's theory of ionic nature and the ageing effect, so that as regards C_2H_2 no serious contradiction to this theory is now encountered.

4. Internal pressures of pure liquids and liquid mixtures. W. WESTWATER, H. W. FRANTZ AND J. H. HILDEBRAND, University of California at Berkeley.—The senior author has shown that ideal solutions can only be formed from liquids having identical values of the coefficient $(\partial P/\partial T)_V$, which is designated γ. Internal pressure may be defined as γT. Experimental determination of values of γ has been made for 8 pure liquids and for 13 of their 50 mol percent mixtures, in order to secure data of importance in studying the deviations of solutions from ideality. The relation between P and T is linear over a range of 20 atmospheres, the slope depending upon the mol volume of the liquid. The following values were obtained in atmospheres per degree for the mol volume corresponding to 20° and 1 atmosphere. (1) heptane, 8.91;

(2) carbon tetrachloride, 11.72; (3) carbon disulfide, 12.95; (4) benzene, 12.92; (5) ethylene chloride, 14.67; (6) bromoform, 16.08; (7) acetone, 11.66; (8) ethylene bromide, 15.87. The 50 mol percent mixtures of the foregoing, referred to by numbers, are as follows: 1–6, 11.03; 2–4, 12.37; 3–4, 12.53; 4–5, 13.18; 4–6, 14.40; 1–7, 9.59; 1–2, 9.89; 1–3, 10.02; 1–4, 10.04; 1–8, 10.97; 3–7, 12.10; 3–8, 14.33; 6–8, 15.94. The values for the mixtures are less than additive and the departure is greater than that calculated from an equation of Biron $\gamma_1\gamma_2/(\gamma_1 N_1+\gamma_2 N_2)$, where N_1 and N_2 represent mol fractions of the constituents.

5. Intermittent photographic exposure as affected by wave-length and intermittency ratio. CLARENCE E. WEINLAND, Stanford University. (Introduced by George R. Harrison). The intermittency effect has been investigated at various wave-lengths in the visible and ultra-violet as far down as λ2537. Intermittent exposures produced by any one of a number of sector discs, each giving a different ratio of flash to rest, allowed any of the following variables to be changed without affecting any other: wave-length, light intensity, frequency of flash, and ratio of flash to rest. The time of exposure was constant at 14 seconds. Cramer Contrast Process and Wratten Panchromatic plates showed a decrease in density of from 15% to 25% with intermittent exposure, this decrease under certain conditions being at λ4358 double its value at λ2537. Eastman 33 and Speedway plates showed only a small intermittency effect, independent of wave-length. On the first two emulsions the difference between densities from intermittent and continuous exposures increased with the ratio of rest period to flash period. An exponential relation fitted this data, at any one set of conditions the difference between densities increasing as a power of the intermittency ratio. It was shown that very large photometric errors can arise when spectra of a spark source are measured on plates calibrated with a non-intermittent source.

6. Band spectra and dissociation of iodine monochloride. G. E. GIBSON AND H. C. RAMSPERGER, University of California at Berkeley.—Thirty-three band heads of ICl were measured in absorption and found to consist of two series, one of them converging at 17410 ± 30 cm^{-1} ($\lambda = 5744$A). Two heads of a third series were faintly in evidence just beyond the convergence, fading out in the region of continuous absorption. The maximum of continuous absorption is about 4800A. Intensity variations with temperature indicate that all three series come from excited states of normal ICl, the observed convergence coming from the first vibrational level. The vibration frequency of normal ICl is 380 cm^{-1}. Interpreted according to the theory of Franck our results indicate that ICl dissociates in light (1) into unexcited atoms, (2) into an unexcited iodine atom and a chlorine atom in the 2^2P_1 state. The convergence corresponding to dissociation into chlorine and excited iodine was not found. Combined with the optical data of Kuhn on Cl_2 and I_2 our results require an evolution of 3.8 cal. for the reaction $ICl = \frac{1}{2}I_2 + \frac{1}{2}Cl_2$, assuming the observed convergence to correspond to process (1). Thermodynamic data give 3.2 cal. for the same reaction. The two faint heads of the third series probably correspond to (2). The thermodynamic measurements are susceptible of accuracy sufficient to exclude definitely other possible interpretations.

7. An electron-quantum theory of galvanomagnetism and thermomagnetism. A. E. CASWELL, University of Oregon.—As yet no satisfactory theory has been proposed to account for the positive sign of the Hall effect and similar discrepancies between observed data and the simple electron theory of this and allied phenomena. The author offers an explanation of the four transverse galvanomagnetic and thermomagnetic effects based upon (1) the well-known behavior of electrons in a magnetic field, (2) an increase in the concentration of free electrons in a metal with rise in temperature, (3) the emission of quanta within a solid conductor, (4) the collision of quanta with electrons according to the laws of mechanics, as applied in the explanation of the Compton effect, and (5) the deflection of a quantum within a metallic conductor by a magnetic field in the same direction as an electron and according to a similar law of force. The first four items are scarcely open to argument. The fifth is a new hypothesis for which the justification rests upon its usefulness in the explanation of observed facts. The theory may be extended to explain the longitudinal effects and gives promise of being valuable in the theory of metallic conduction.

8. Effect of a magnetic field upon thermal conductivity of iron, copper, silver and gold. HUGH M. BROWN, University of California at Berkeley.—In this work the thermal conductivity is measured in both longitudinal and transverse fields by O' Day's application of the "Bar Method." The bars were 4″ long, and $\frac{1}{8}$″ in diameter. The precision was sufficient to

easily detect a change in thermal conductivity of 0.1 percent. Longitudinal fields of 10,000 and 5,000 gauss, and transverse fields of 8,000 and 4,000 gauss were used. In iron, the longitudinal field produced a decrease of 1.14 percent in the heat conductivity. The transverse field of 4,000 gauss decreased the heat conductivity of 0.4 percent, while in the field of 8,000 gauss, the change was less than 0.1 percent. This behavior parallels the change in resistance of iron observed by others. For copper, the two longitudinal fields decreased the thermal conductivity 0.23 and 0.21 percent respectively. The transverse fields produced no change as great as 0.1 percent. In silver and gold, none of the fields produced as much as 0.1 percent change. The resistance of iron was increased 0.2 percent by the longitudinal field of 10,000 gauss, while no change in resistance was observed in the other metals. No change could be detected in the thermal e.m.f. constant of the thermocouples. Thus, copper, the only non-magnetic metal showing an appreciable effect, behaves as the magnetic ones, nickel and iron. Livens' theory predicts an increase in the thermal conductivity by the magnetic field, and hence is not checked by this research.

9. Magnetic spectrum of secondary electrons. J. B. BRINSMADE, California Institute of Technology.—An aluminum target was bombarded with homogeneous streams of primary electrons (velocities ranging up to 172 volts) and the velocity distribution of the resulting secondary electrons studied with a magnetic analyser and electrometer. Other observers report a peak near the primary velocity and a broad distribution with a low velocity hump. The present apparatus has sufficient resolving power to show that the former peak is extremely sharp consisting only of electrons "reflected" from the target with no appreciable loss of energy. The coefficient of reflection is of the order of 10^{-3} per unit solid angle at the deviation used (approximity 90°). It increases somewhat with decreasing primary velocity. At this deviation, the full velocity electrons constitute about 2% of the secondary current with 172 volt primary velocity and 10% with 34 volt.

10. An experimental study of the relative intensities of x-ray lines in the L-spectrum of thorium. SAMUEL K. ALLISON, University of California at Berkeley.—The relative intensities of the thorium L-series lines at 31.8 kilovolts have been measured using an ionization spectrometer with methyl iodide in the ionization chamber. The relative intensities of the lines at high voltage was calculated from the observed intensities at 31.8 kilovolts by studying the variation of the intensity of the lines with voltage. It was found that this could be expressed in the range studied by $I=k(V-V_0)^2$. The results are corrected for absorption inside and outside the ionization chamber. The intensity rules for the doublets hold for the lines involving L_{21} and L_{22}. The predictions of Wentzel based on Schrödinger's mechanics for the relative intensities of "sharp" and "diffuse" doublets are confirmed, but the experimental intensities of the "principal" series doublets are too low by a factor of 7. They are also too low in the measurements of Jönsson on tungsten.

Line	l	α_2	α_1	η	β_6	β_2	β_7	$\beta_1+\beta_5$	β_3	γ_5	γ_1	γ_2	$\gamma_3+\gamma_6$	γ_4
Obs. Int.														
31.8 kv	3.6	12	100	1.1	1.4	26	.45	38	1.8	0	8.5	.81	3.1	0
Calc. Int.														
High voltage	3.6	12	100	1.8	1.4	26	.45	62	3.3	0	14	1.5	5.3	0

11. Direct and indirect ejection of K electrons by cathode rays. DAVID L. WEBSTER, Stanford University.—When cathode rays strike a block of metal, they may eject electrons from the K orbits of atoms, either by direct action or by an indirect, photoelectric process, through continuous-spectrum x-rays. The present experiments distinguish these two types of K ionizations by their mean depths in the metal, the indirect being deeper. Two methods were used. One was by determination of the ratio of $K\alpha$-line intensity of silver to continuous-spectrum intensity of the same wave length (ratio of line area to continuous-spectrum ordinate) for rays emerging from the surface at 20°, 5° and less than 1°. The other method was by calculation from relative intensities of $K\alpha$ lines from a composite target, made of a block of cadmium covered with silver, thick enough to stop cathode rays but thin enough to let through a reasonable fraction of the x-rays. The first method showed merely that a majority of the K rays were from direct ionizations. The second, with three different thicknesses of silver, showed that at 50 kv (nearly 2 V_K) the ratio of direct ionizations to indirect was 2.4, with a mean deviation 7%, and probable error somewhat greater.

SUPPLEMENTARY PROGRAM

To be given at end of the morning session.

Large losses of energy by cathode rays: ratio of the probabilities of the two types. DAVID L. WEBSTER, Stanford University.—Cathode rays penetrating a heavy element may lose energy in large amounts, either by imparting it to atomic electrons or by radiating quanta belonging to the continuous spectrum. Let Q be the ratio of the probability that a cathode ray ejects a K electron to the probability that it radiates a continuous spectrum quantum with $\nu > \nu_K$; and let P be the ratio given in a previous abstract in this program, of the probability of K ionization by direct action of a cathode ray to K ionization by indirect, photoelectric action. Then if the energy distribution in the continuous spectrum is known except for a constant factor, the ratio Q can be calculated, from it and P. Using Kulenkampff's continuous-spectrum formula, it appears that for silver at 50 kv., Q is nearly unity. Some change in Q with voltage may occur in silver; and a comparison with Beatty's and Unnewehr's data indicates that Q for copper is two or three times as great. Incidentally, in silver at 5.0 kv, the indirect Kα-line rays carry energy equivalent to a region of continuous spectrum about 30′ wide, and the direct rays about 70′.

PROGRAM OF THE JOINT SESSION WITH THE ASTRONOMICAL SOCIETY OF THE PACIFIC

This session will be held Thursday, June 23, in the afternoon, at a time and place to be announced at the morning session.

The titles of all papers to be presented at this session will be found in the program of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, while abstracts not given here will be found in the publications of the Astronomical Society of the Pacific.

13. Revision of Rowland's preliminary tables of solar spectrum wave-lengths. CHARLES E. ST. JOHN, Mount Wilson Observatory.

14. Magnetic storms and solar activity. HAZEL MARIE LOSH, Mount Wilson Observatory.

15. The relationship of spectral types to period among variable stars. WALTER F. ADAMS AND ALFRED H. JOY, Mount Wilson Observatory.

16. The flash spectrum. DONALD H. MENZEL, Lick Observatory.

17. A group of sun spots in high latitude with irregular polarity. LEWIS H. HUMANSON, Mount Wilson Observatory.

18. The theoretical relation between infra-red and ultra-violet bands. R. T. BIRGE AND J. J. HOPFIELD, University of California at Berkeley. According to the present interpretation of band spectra, the frequency of infra-red (vibration-rotation) bands of a diatomic molecule can be calculated from the measured frequencies of certain ultra-violet (electronic) bands correlated with the normal state of the molecule. Carbon monoxide furnishes the only quantitative test known thus far. Schaefer and Thomas observed infra-red bands at 4.67μ, 2.35μ, and 1.573μ (in air), while Birge (Phys. Rev. **28,** 1168, 1926), from the fourth positive group of carbon, using data of Deslandres and Lyman, *calculated* the infra-red bands as 4.679μ, 2.354μ, and 1.578μ (in vacuum). We have now, from our own plates, obtained more accurate data for this ultra-violet (resonance) system of CO, yielding for the infra-red bands 4.6684μ, 2.3481μ, and 1.5748μ (in vacuum) with a probable error of about one part in 2000, or 4.6672μ, 2.3475μ, and 1.5744μ in air. Because of the greater resolution and sensitivity of the photographic plate, compared to infra-red recording apparatus, the above remarkable confirmation of theory encourages the hope of obtaining infra-red standards from measurements of ultra-violet radiation, in the case of band spectra, as well as in the now familiar case of line spectra.

19. Characteristics of the Neutral and of the singly and doubly ionized spectra of cerium. ARTHUR S. KING, Mount Wilson Observatory. By comparing the arc and spark spectra of cerium with that of the electric furnace, it has been possible to distinguish between the ionized spectrum, which, presumably because of a low ionization potential, forms the major part of the conspicuous lines of the arc, and the spectrum of the neutral atom. The latter, for which the furnace is the only effective source, has been to a large extent unrecognized, at least in the ordinary photographic region. The furnace spectrograms made in the present investigation have permitted the measurement of approximately 1600 neutral lines between λ3000 and λ4700, of which only a few of the strongest had been previously measured in the arc spectrum. In the yellow and red, the neutral spectrum becomes strong in the arc, and has been measured by Kiess and others, so that over 3000 neutral lines may be listed. The very rich spectrum of ionized cerium is common to the arc and spark, while in the ultra-violet a condensed spark discharge gives a large collection of doubly-ionized lines, of which only the strongest group has been previously measured. Preliminary observations indicate that very similar characteristics prevail for the spectrum of the related rare earth, neodymium.

20. The structure of the atmospheric absorption bands of oxygen. G. H. DIEKE, California Institute of Technology, and HAROLD D. BABCOCK, Mount Wilson Observatory. The wave-lengths of all suitable lines were determined by the interferometer. (H. D. Babcock, Astrophysical Journal, **65**, 140, 1927). The others were measured on high dispersion grating plates taken on Mt. Wilson, the broad lines in the A-band by a registering microphotometer. These accurate wave-lengths permit a test of the combination principle, and it is possible to obtain the quantum interpretation of the bands, and confirm the classification of the lines by previous observers. The short wave-length components of the apparent doublets show marked deviations from Deslandres' law in the vicinity of the zero line, whereas no appreciable deviations are found for the long wave-length components. The doublets are electronic doublets and seem really to belong to a triplet system, the other components being forbidden by the selection rules. There are faint doublets which only in the A-band have sufficient intensity to be measured and which have exactly the same structure as the strong ones, the only difference being the value of the constant B(Rotational term $= Bm^2$). The faint and strong doublets have the same zero lines. The moment of inertia of the oxygen molecule in the normal state is 19.27×10^{-40} gm cm.^{2}

21. Pressure effect for iron-arc lines. HAROLD D. BABCOCK. Mount Wilson Observatory. Accurate measurements of the displacement corresponding to one atmosphere change of pressure have been made with the interferometer for about 100 lines in the visible region. Special attention has been given to the elimination of pole-effect from the observations. Members of pressure-groups *a*, *b*, *c*, *d* and *e*, and of 33 multiplets are studied, as well as 17 lines not yet assigned to multiplets. The following summary expresses the present state of the investigation: 1. All wave-lengths increase with pressure. 2. For a given line the change in λ is proportional to the change in pressure. 3. Members of a multiplet behave alike. 4. The pressure displacement is the result of differential depression of the two polyfold terms whose differences correspond to the lines of a multiplet. 5. Assuming the depression of the lowest term in the atom to be zero, the depressions of many higher terms have been derived. 6. For 15 Septet and Quintet terms the decrease in term value is nearly proportional to the square of the level. 7. For Triplet terms a different relation holds. 8. Pressure effect may now be computed for many multiplets not yet measured.